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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 10/077,967 | 02/20/2002 | Sarah E. Kim | 219.40232X00 | 6471 |

20457 7590 09/17/2003

ANTONELLI, TERRY, STOUT & KRAUS, LLP
1300 NORTH SEVENTEENTH STREET
SUITE 1800
ARLINGTON, VA 22209-9889

EXAMINER

TRINH, MICHAEL MANH

ART UNIT

PAPER NUMBER

2822

DATE MAILED: 09/17/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) |
|------------------------------|-----------------|--------------|
| | 10/077,967 | KIM ET AL. |
| Examiner | Art Unit | |
| Michael Trinh | 2822 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) Responsive to communication(s) filed on 25 June 2003.

2a) This action is **FINAL**. 2b) This action is non-final.

3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) Claim(s) 1-32 is/are pending in the application.

4a) Of the above claim(s) 19-32 is/are withdrawn from consideration.

5) Claim(s) _____ is/are allowed.

6) Claim(s) 1-18 is/are rejected.

7) Claim(s) _____ is/are objected to.

8) Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) The specification is objected to by the Examiner.

10) The drawing(s) filed on _____ is/are: a) accepted or b) objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) The proposed drawing correction filed on _____ is: a) approved b) disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12) The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) All b) Some * c) None of:

1. Certified copies of the priority documents have been received.
2. Certified copies of the priority documents have been received in Application No. _____.
3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14) Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) The translation of the foreign language provisional application has been received.

15) Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) Notice of References Cited (PTO-892)
2) Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4.
4) Interview Summary (PTO-413) Paper No(s). ____.
5) Notice of Informal Patent Application (PTO-152)
6) Other: _____.

DETAILED ACTION

*** This office action is in response to Applicant's election filed on June 25, 2003. Claims 1-32 are pending.

Election/Restrictions

1. Claims 19-32 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election filed on June 25, 2003 was made of claims 1-18, without traverse in Paper No. 6.

Claim Rejections - 35 USC § 112

2. Claims 2,4-7,12 and 17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 7 and 17, lines 3, using the term "...such as..." renders scope of the claim being unclear whether the subsequent limitations are parts of the claims. The term "such as" should be deleted.

Meaning and scope of "barrier/seed" as claims 2,9 and 12 are unclear, since dependent claim 5 indicates "/" as --and--. It should be --barrier and seed--

(Dependent claim are rejected as depending on rejected base claim)

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless -

- (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
- (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
- (c) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

4. Claim 1 is rejected under 35 U.S.C. 102(b) as being anticipated by Hsu (5,627,106).

Hsu teaches a method for vertically stacking wafers comprising at least the steps of: selectively depositing a plurality of metallic lines 20,46 on opposing surfaces of adjacent wafers (Figs 8 and 9; col 3, line 5-20); bonding the adjacent wafers, via respective metallic lines 20 and 46 on opposing surfaces of the adjacent wafers, to establish electrical connections between the active devices on the vertically stacked wafers (Figs 10; col 3, line 21 through col 4, line 15); forming one or more vias to establish electrical connections between the active devices on the vertically stacked wafers (Fig 12) and an external interconnect 26.

5. Claims 1,3,7, and 11 are rejected under 35 U.S.C. 102(b) as being anticipated Fan et al (Article of “Copper Wafer Bonding”).

Fan et al teach a method for vertically stacking wafers comprising at least the steps of: selectively depositing a plurality of metallic lines of copper on opposing surfaces of adjacent wafers (Figs 1-2; page 534, left column); bonding the adjacent wafers, via respective metallic lines on opposing surfaces of the adjacent wafers, to establish electrical connections between the active devices on the vertically stacked wafers, wherein the vertically stacked wafers include one or more inter-wafer vias to establish electrical connections between the active devices and an external interconnect. Re claim 3, wherein the metallic lines are copper (Fig 2, Page 534, left column). Re claim 7, wherein dummy vias are arranged on the opposite surfaces of the wafers to increase surface area for bonding and serve as ground plane or heat conduits (page 534, left column, third paragraph). Re claim 11, wherein, as shown in Figure 2, the inter-wafer via is formed in the top wafer during a shallow trench isolation process before bonding the adjacent wafer, via the respective metal lines deposited on opposing surfaces of the adjacent wafers.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

7. Claims 2,4-6,9-10,12-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fan et al (Article of “Copper Wafer Bonding”) taken with You et al (6,100,181) and McDonald (Article of “Face to Face Wafer Bonding...”).

Fan teaches a method for vertically stacking wafers as applied above to claims 1,3,7, and 11. Re further claims 2,9 and 12, wherein the via is formed by selectively etching the top wafer, wherein an oxide spacer is used to insulate a sidewall of the via (Page 534, left column, second and third paragraphs); forming a barrier layer in the via for the metal liner; and depositing a conductive metal on the barrier layer in the via for providing electrical connection between the active devices. Re claim 17, wherein dummy vias are arranged on the opposite surfaces of the wafers to increase surface area for bonding and serve as ground plane or heat conduits (page 534, left column, third paragraph).

Fan already forms the via for electrical connection, but lacks mentioning a seed layer of copper and a copper conductive metal for forming the via and materials for the barrier layers (re claims 2, 4-6,10,14-16), and lacks forming the via by selectively etching the top wafer (re claims 2,9,12), by dual damascene process as in claim, and stopped by a conductive plug (re claim 12).

However, You teaches (Figs 2-3; col 1, lines 30-41; col 2; col 4, lines 1-15; col 6, lines 1-13;) forming a via for electrical connection, wherein a copper seeding layer 126 is deposited over a barrier layer 126 of a materials including tantalum, tantalum nitride, titanium, tungsten, wherein a conductive metal 104 of copper or copper alloy is deposited on the copper seed layer formed by chemical vapor deposition (col 5, lines 5-16), wherein the via having an upper trench and a lower trench is formed by a dual damascene process by selectively etching the upper trench, and wherein etching to form via is stopped by a conductive plug 102. McDonald teaches

(at Fig 2; Pages 90) forming the via by selectively etching the top wafer of the vertically stacked wafers, wherein etching to form the via is stopped by a conductive plug formed in a bottom wafer (Fig 2), and wherein the via is then CVD lined and Cu filled to provide electrical connection between the active devices on the vertically stacked wafers.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the via for electrical connection of Fan et al by selectively etching the top wafer of the vertically stacked wafers and then depositing a copper conductive metal on a copper seeding layer formed on a barrier layer over a dual damascene via, as combinatively taught by McDonald and You et al. This is because of the desirability to form copper vias having high electrical conductivity for providing good electrical connection between the active devices, wherein the substitution of art recognized equivalent metal materials for the barrier layer and the conductive metal would have been obvious and within the level of ordinary skill in the art and for prevent unwanted interdiffusion, and wherein the dual damascene eliminates metal etch and dielectric gap filling.

8. Claim 8 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fan et al (Article of "Copper Wafer Bonding"), as applied to claims 1,3, 7 and 11 above, and further in view of Idaka et al (5,473,197) or Kurt (5,455,445).

Fan teaches a method as applied to base claims 1 and 12 above.

Fan lacks forming the vias having tapered shape.

However, Idaka teaches (at Figs 8C-9C; col 6, lines 33-67) forming the vias having tapered shape. Kurt also teaches (at Fig 1; col 2) forming the vias 18a-d having a tapered shape from top to bottom of the via.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the vias of Fan by forming the via having a tapered shape from top to bottom of the via as taught by Idaka or Kurt. This is because of the desirability increase the top surface area for easily connection.

Art Unit: 2822

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael M. Trinh whose telephone number is (703) 308-2554. The examiner can normally be reached on M-F from 8:30 Am to 4:30 Pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (703) 308-4905. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Oacs-4



Michael Trinh
Primary Examiner